REMARKS

Status of the Claims

Claims 1-15 are pending. Claims 1-15 are rejected. Claims 1-4, 7-12 and 15 are amended herein. Claims 5-6 and 13-14 are canceled. No new matter has been added.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendments. The attached page is captioned "**VERSION WITH MARKINGS TO SHOW CHANGES MADE**". Reconsideration of the pending claims is respectfully requested.

Claim objections

Claim 3 is objected to for reciting "...activating...through a means...". Claims 3 and 11 are amended to recite "...activation of said fluorine gas is via..." or "activating said fluorine gas via...", respectively.

Amendments to the claims

Claims 1-7 are amended to overcome a 35 U.S.C. 112, second paragraph, rejection to clarify the language "feed gas does not

clean the process chamber..." and to correct spelling and grammar errors. As amended, claim 1 further overcomes rejection under 35 U.S.C. 102 as being anticipated by **Dyer** and **Nowack** *et al.* Amended claims 1 and 8 also overcome rejection under 35 U.S.C. 103 as obvious over **Shang** *et al.*, in view of **Nicolas** and **Karwacki** *et al.* Amended claim 1 is now drawn to a method of on site generation of a fluorine cleaning gas and incorporates dependent claims 5-6. Amended claim 8 is now drawn to a method of cleaning a process chamber using on site generation of the fluorine cleaning gas and incorporates claims 13-14 as discussed *infra*. Claims 2-4, 7, 9-11, and 15 are amended to properly depend from and limit amended claims 1 and 8. No new matter is included.

An inventive concept of Applicants' invention is to a method of generating a cleaning gas on site from a non-cleaning gas to be used to clean a process chamber by further activating the cleaning gas to form reactive species, e.g. fluorine radicals. Particularly, the use of hydrofluoric acid to generate fluorine gas on demand and on site with but at a distance from the process chamber provides an efficient way of providing reactive fluorine species for cleaning while minimizing storage of fluorine gas which is hazardous. Additionally, using hydrofluoric acid as a generator is less expensive

on site.

than such gases as NF_3 or less polluting than cheaper global warming gases such as SF_6 and C_2F_6 (pg. 3, ll. 23-29; 17-20).

The specification teaches that fluorine gas is generated from hydrofluoric acid; the resultant gas is a mixture of hydrofluoric acid gas and fluorine gas. Transferring the gas mixture to a cold trap condenses the hydrofluoric acid to a liquid while leaving the fluorine in a gaseous state to be temporarily and optionally pumped to a storage cylinder. The fluorine gas is then removed to the process chamber and activated to form reactive species or it can be activated at a remote location subsequent to delivery to the process chamber to be used to clean the chamber (pg. 7, ll. 7-15).

<u>The 35 U.S.C. §112, second paragraph, rejection</u>

Claims 1-7 are rejected under 35 U.S.C §112, second paragraph as being indefinite. Applicants respectfully traverse this rejection.

The recitation in claim 1 of "...feed gas does not clean the process chamber..." constitutes and indefinite subject matter, because it is not clear whether the feed gas doesn not react with chamber residues or the feed gas is not supplied to the process chamber, however could react with residues if supplied. Additionally, this is a

negative limitation and does not point out what was done but what wasn't done. Applicants have amended claims 1-7 as discussed *supra*. The claims now refer to specific gases, i.e., hydrofluoric acid and fluorine gas, and how fluorine is generated from hydrofluoric acid and the relationship of each to the cleaning process for the chamber. Accordingly, in light of the amendments made *supra*, Applicants respectfully request that the rejection of claims 1-7 under 35 U.S.C. 112, second paragraph be withdrawn.

The 35 U.S.C. §102 rejections

Claim 1 is rejected under 35 U.S.C. 102(e) as anticipated by **Dyer** (U.S. 6,209,483) and by **Nowak** et al. (U.S. 6,366,346). Applicants respectfully traverse this rejection.

The Examiner states that **Dyer** teaches a method of removing residues from a CVD processing chamber utilizing fluorine ions and free radicals produced in a high density plasma pre-ionization module from non-green house gases, e.g., C_2F_5H or CF_3H (Abstract: col. 2, ll. 40-43; 29-35). Further, **Dyer** specifically states that etching of residues like silicon dioxide is dominated by fluorine ions and free radicals (col. 1, ll. 20-22) and cleaning with

hydrogenated PFC gases or HF is inefficient and should be avoided (col. 1, ll. 63-65; col. 2, ll. 1-5).

Dyer teaches a method of cleaning a CVD reactor by generating fluorine ions or radicals from a non-green house gas perfluorinated carbon/oxygen plasma where the presence of oxygen in the plasma decreases PFC polymerization and increases fluorine radical concentration (Abstract; col. 1, ll. 54-col. 2, ll. 7). Addition of hydrogen to the PFC/oxygen plasma is contraindicated because it reduces the concentration of fluorine radicals by forming HF and enhancing polymer generation (col. 1, ll. 45-47).

With regard to **Nowak** *et al.*, the Examiner states that a method of cleaning substrate processing chambers utilizing remotely generated plasma is taught. A microwave plasma dissociates a precursor into chemically active species such as fluorine radicals that are transported into the process chamber to react with the deposition residue during the cleaning (col. 2, ll. 18-26). As up to 99.9% of the precursor is dissociated or converted into active fluorine radicals, the precursor does not clean the processing chamber (paragraph bridging col. 7-8).

Nowak *et al.* teaches a method and apparatus for optically determining the composition of a plasma formed from an

effluent stream from a vacuum processing chamber (Abstract; col. 1, ll. 4-8). This can be used to monitor cleaning of the chamber by measuring the amount of fluorine found in a plasma generated in the exhaust stream, i.e., the greater the concentration of fluorine the closer to completion the cleaning process is. The fluorine radicals are generated from a fluorine-containing precursor in a remote microwave plasma generator (col. 3, ll. 15-27).

Applicants' invention, as recited in amended claim 1 and discussed *supra*, is to a method of generating a fluorine cleaning gas on site from hydrofluoric acid. The hydrofluoric acid forms a gas mixture of hydrofluoric acid gas and fluorine cleaning gas. The mixture is transferred to a cold trap, hydrofluoric acid gas is liquified and separated from the fluorine gas. The remaining fluorine gas is further activated to form reactive fluorine species. Regardless of the gases that are used to generate reactive fluorine species, neither **Dyer** nor **Nowack** *et al.* teach a method of generating the cleaning gases that are subsequently activated to form the reactive fluorine species.

For a valid §102 rejection, the prior art references must contain each element of the claimed invention. Absent teachings of on site generation of a cleaning gas from a non-cleaning gas prior to

the cleaning gas being activated to form a reactive species for cleaning a process chamber as recited in amended claim 1, neither **Dyer** nor **Nowak** *et al.* anticipate Applicants' claimed invention. Therefore, as these references are not valid prior art against the instant application under 35 U.S.C. §102(e) and in view of the preceding amendments and remarks, Applicants respectfully submit that the cited references do not anticipate claim 1 under 35 U.S.C. §102(e). Accordingly, Applicants respectfully request that the rejection of claim 1 under 35 U.S.C. §102(e) be withdrawn.

The 35 U.S.C. §103(a) rejection

Claims 1-15 are rejected under 35 U.S.C. §103(a) as being unpatentable over **Shang** et al. (U.S. 5,788,778) in view of **Nicolas** (U.S. 5,284,605), and in further view of **Kawacki** et al. (U.S. 5,569,151). Applicants respectfully traverse this rejection.

The Examiner states that **Shang** *et al.* teaches a method of cleaning a deposition chamber by delivery of reactive gas, such as fluorine, into a remote plasma chamber, activating the gas and flowing the activated species into the deposition chamber to clean it (Abstract; col. 6, ll. 27). Further, that **Shang** *et al.* is silent about how the cleaning gas is obtained and stored is immaterial for the cleaning

process per se, unless criticalities of such specific steps are provided. **Nicolas** teaches that fluorine gas is generally obtained by electrolysis of anhydrous hydrofluoric acid and that the fluorine produced may carry some HF which may be an impurity (col. 1, ll. 17-24). Hydrofluoric acid is separated from the fluorine gas by refrigerating the gaseous mixture and by condensing the hydrofluoric acid to form a liquid to obtain a pure fluorine gas (col. 2, ll. 5-22). **Karwacki** *et al.* teaches filling, storing and delivery of fluorine to the processing site (col. 2, ll. 44-48; col. 3, ll. 52-60). Thus a person skilled in the art would have found it obvious to obtain purified fluorine as per **Nicolas** and to deliver it to the processing site of **Shang** *et al.* in the safe container of **Karwacki** *et al.* in order to facilitate the process of Shang with reasonable expectation of success.

Shang *et al.* teach a process of cleaning a deposition chamber by activating a halogen containing precursor gas, e.g., NF3, in a remote chamber via a high power source such as radiofrequency. The reactive species are flowed into the deposition chamber to clean it (Abstract; col. 6, ll. 23-32; col. 2, ll. 46-67). **Karwacki** *et al.* teach a system for handling and transporting dangerous gases that may leak or vent from a primary container by using an outer containment vessel to hold an inner containment vessel containing the gas, an

not only ?

example being the delivery and handling of fluorine gas to be used in an excimer laser (Abstract; col. 2, ll. 37-47).

Nicolas teaches a process of treating a gas containing fluorine, gaseous anhydrous hydrofluoric acid from an electrolytic process to produce fluorine, gaseous uranium hexafluoride, and non-condensable gases such as nitrogen and oxygen to separate the components into fluorine and non-condensable gases and hydrofluoric acid and uranium hexafluoride via refrigeration (col. 1, ll. 41-47; col. 2, ll. 5-32). Electrolysis of HF produces an HF/F2 gas mixture which is used to burn solid uranium compounds to produce gaseous uranium hexafluoride (col. 1, ll. 17-27). After separation the fluorine gas and non-condensable gases are discharged to be reused in combustion or treated to remove fluorine as potassium fluoride or calcium fluoride (col. 3, ll. 14-24).

Applicants invention is as discussed *supra*. Applicants have amended independent claims 1 and 8 as also discussed *supra*. As such, these amended claims are drawn to a method of generating a fluorine cleaning gas from hydrofluoric acid on site with the processing chamber but remote to it to be used in a cleaning process for the process chamber and a method of cleaning the process chamber using the generated fluorine gas. The Examiner's assertions

with regard to the cleaning gas used in **Shang** *et al.* notwithstanding, how the cleaning gas is obtained and stored in the instant invention is material for the cleaning process. The use of hydrofluoric acid for the on site generation of fluorine cleaning gas provides a cheaper, less environmentally impacting and safer method of cleaning the process chamber.

With regard to **Nicolas** a known process is disclosed of fluorine gas generation using hydrofluoric acid to produce fluorine; the fluorine gas so generated is used in a combustion process to produce uranium fluorides and in a new process the remaining reactants and products of the combustion are subsequently separated for reuse via refrigeration. In considering that the cleaning method of **Shang** *et al.* can use any commonly used halogen or halogen compound from which to remotely generate reactive species and further, as the invention is to the remote activation of cleaning gases and the cleaning gases encompass a wide range of available compounds, no motivation is found to alter the method of **Shang** *et al.* to limit the method by requiring on site generation of the fluorine gas as disclosed in **Nicolas**. Also, no teaching or suggestion is found in **Nicolas** to use such a method in another system requiring fluorine gas.

In considering **Karwacki** *et al.* Applicants reiterate that on demand generation of fluorine gas minimizes storage of the gas particularly as using a temporary storage container after removing the fluorine gas from the cold trap is optional. Therefore, the instant invention as recited in amended independent claim 8 obviates the need for a delivery and storage system for fluorine gas as disclosed in **Karwacki** *et al.* The fluorine gas is not transported to the processing chamber site, it is produced on site and should temporary storage of the fluorine gas be necessary prior to activation thereof, a 100 liter storage container is connected to the cold trap. Additionally, as storing the fluorine gas is a limitation of a claim dependent on amended claim 8, combining **Karwacki** *et al.* with **Shang** *et al.* does not render the invention obvious in view of Applicants' assertions that **Shang** *et al.* does not render the invention obvious.

The Examiner states that a "new" process can still be obvious when considered as a whole notwithstanding that specific starting materials are not disclosed in the prior art. Applicants further submit that there must be a teaching, suggestion or motivation **in the prior art** (Applicants' emphasis) to combine those elements taught in the prior art thereby rendering the invention obvious as a whole. It may be construed that, as **Shang** *et al.* teaches

cleaning using remotely activated fluorine species, **Nicolas** teaches that fluorine gas is generated via electrolysis of anhydrous hydrofluoric acid and **Karwacki** *et al.* teaches a transport/storage container for fluorine gas, each element of the instant invention is separately taught. However, no teaching or suggestion is found in **Nicolas** that the fluorine gas generation or refrigerated separation techniques may be applied to a system other than one for producing uranium fluorides nor in **Shang** *et al.* that the cleaning gas, particularly fluorine gas, from which activated species are obtained may itself be generated on site. Absent a teaching or suggestion to combine, the instant invention is not obvious as a whole; hindsight can not be used to assert obviousness.

[illegible]

In view of the above remarks, Applicants respectfully submit that obviousness can not be established by combining the teachings of the prior art absent some teaching, suggestion or motivation supporting the combination to do so. Thus, the invention as a whole was not obvious to one of ordinary skill in the art at the time the invention was made. Accordingly, Applicants respectfully request that the rejection of claims 1-15 under 35 U.S.C. §103(a) be withdrawn.

This is intended to be a complete response to the Office Action mailed August 14, 2002. If any issues remain outstanding, the Examiner is respectfully requested to telephone the undersigned attorney of record for immediate resolution. Applicants believe that no fees are due, however, should this be in error, please debit Deposit Account No. 07-1185 on which the undersigned is allowed to draw.

Respectfully submitted,

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Benjamin Aaron Adler, Ph.D., J.D.
Registration No. 35,423
Counsel for Applicant

ADLER & ASSOCIATES
8011 Candle Lane
Houston, Texas 77071
(713) 270-5391 (tel.)
(713) 270-5361 (facs.)
BADLER1@houston.rr.com

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please amend claim 1 as follows:

1. (amended) A method ~~for cleaning~~ of on site generation of a fluorine cleaning gas from hydrofluoric acid to be utilized in a cleaning process for a process chamber for semiconductor and/or flat panel display manufacturing, comprising the steps of:

converting ~~a~~ hydrofluoric acid ~~feed gas~~ to a mixture of hydrofluoric acid gas and said fluorine cleaning gas ~~in a remote location, wherein said feed gas does not clean~~ on-site but remote to the process chamber; ~~and~~ 112/2

~~delivering said~~ transferring the gas mixture to a cold trap;

converting said hydrofluoric acid gas to a liquid; and

separating said liquid hydrofluoric acid from said fluorine gas, said fluorine cleaning gas remaining in a gaseous state thereby generating said fluorine cleaning gas for utilization in said cleaning ~~gas to the~~ process ~~chamber~~.

Please amend claim 2 as follows:

2. (amended) The method of claim 1, ~~further comprising the step of:~~

~~activating~~ wherein said fluorine cleaning gas is utilized through activation thereof to form reactive fluorine species to clean the process chamber, said reactive fluorine species formed inside the process chamber or said reactive fluorine species formed outside the process chamber ~~prior to delivering said cleaning gas~~ and subsequently delivered to the process chamber.

specie

Please amend claim 3 as follows:

3. (amended) The method of claim 2, wherein ~~said step of activating~~ activation of said fluorine cleaning gas is via ~~performed through a means selected from the group consisting of~~ a ~~remote~~ plasma source, a heat source, ~~and~~ or an electrical source.

Please amend claim 4 as follows:

4. (amended) The method of claim 3, wherein said ~~remote~~ plasma source is ~~selected from the group consisting of~~ a microwave energy source ~~and~~ or a radiofrequency energy source.

Please amend claim 7 as follows:

7. (amended) The method of claim ~~6~~ 1, wherein ~~the conversion~~ converting said hydrofluoric acid is ~~done by~~ via electrolysis.

Please amend claim 8 as follows:

8. (amended) A method for cleaning a process chamber for semiconductor and/or flat panel display manufacturing, comprising the steps of:

generating a fluorine cleaning gas on-site with but remote to the process chamber, said generating step comprising:

converting ~~a feed~~ hydrofluoric acid ~~gas~~ to a ~~cleaning gas,~~ mixture of said hydrofluoric acid gas and said fluorine gas ~~in a remote location, wherein the resulting gas is a mixture of the feed gas and the cleaning gas~~;

transferring the ~~resulting~~ gas mixture to a cold trap~~,~~ and

~~wherein the feed gas is converted~~ converting said hydrofluoric acid gas into a liquid ~~form, and~~

removing said liquid hydrofluoric acid from the cold trap, ~~the~~ said fluorine cleaning gas ~~remains~~ remaining in a gaseous form; and

~~delivering said cleaning gas to~~ activating said fluorine cleaning gas to form fluorine radicals to clean the process chamber.

Please amend claim 9 as follows:

9. (amended) The method of claim 8, wherein ~~prior to~~ said ~~step of~~ ~~delivering~~ ~~the~~ fluorine cleaning gas is pumped into a storage unit prior to said activating step ~~to the process chamber, further comprising the step of:~~

~~pumping the cleaning gas into a storage unit~~.

Please amend claim 10 as follows:

10. (amended) The method of claim ~~9~~ 8, ~~after the step of pumping the cleaning gas into a storage unit, further comprising the step of:~~ wherein said fluorine cleaning gas is activated to form fluorine radicals inside the process chamber or wherein said fluorine cleaning gas is activated to form fluorine radicals ~~activating the cleaning gas~~ outside the process chamber, said fluorine radicals subsequently delivered ~~before delivering the cleaning gas~~ to the process chamber. Specie

Please amend claim 11 as follows:

11. (amended) The method of claim ~~10~~ 8, wherein ~~said step of~~ activating said fluorine cleaning gas is ~~performed through a~~

~~means selected from the group consisting of~~ via a ~~remote~~ plasma source, a heat source, ~~and~~ or an electrical source.

Please amend claim 12 as follows:

12. (amended) The method of claim 11, wherein said ~~remote~~ plasma source is ~~is selected from the group consisting of~~ a microwave energy source ~~and~~ or a radiofrequency energy source.

Please amend claim 15 as follows:

15. (amended) The method of claim 14, wherein ~~the conversion~~ converting said hydrofluoric acid gas is ~~done by~~ via electrolysis.

Please cancel claims 5-6 and 13-14.